

Maths complements for Computational Mechanics a ATENEA Labs

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Matemàtica Aplicada III
- Email: m.rosa.estela@upc.edu
- Resum: Els estudiants que ingressen als màsters en anglès de la UPC provinents d'altres països sovint tenen carències en coneixements bàsics de matemàtiques que s'imparteixen al primer cicle (Bachelor). El nostre projecte consisteix en la creació d'un curs a Moodle en anglès, a on poden trobar aquestes conceptes requerits a les assignatures de màster. En aquest curs a més de la teoria i exemples, hi ha exercicis interactius que faciliten l'autoaprenentatge, així com diferents test d'autoavaluació utilitzant WirisQuizzes.
- Paraules clau: Maths, Màster, Moodle, WIRIS

Curs a Moodle



Plataforma de suport a la docència



AteneaLabs ► ETSECCPBMMCCM091

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Turn editing on

Maths complements for Computational Mechanics (Curs)

Bibliotècnica

Com recuperar continguts d'assignatures anteriors

Topic outline

This interactive tool has been designed to complement the background in basic mathematics for the students in engineering and scientific master programs. In particular, basic results in linear algebra, calculus and differential equations (both ODEs and PDEs) are reviewed, aiming at covering the knowledge required to follow advanced courses.

Usage tips for students

Glossary

News forum

Latest News

Add a new topic...
(No news has been posted yet)

Activities

- Forums
- Glossaries
- Quizzes
- Resources

People

Participants

Calendar

May 2010

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Events Key

- Global
- Course
- Group
- User

1 Linear Algebra

- 1.0 Vector Algebra
 - 1.0.1 Operations
 - 1.0.2 Vector space basis
 - 1.0.3 Scalar product
 - 1.0.4 Vector product
 - 1.0.5 Vector triple product
 - 1.0.6 Triple vector product
- 1.1 Matrices
 - 1.1.1 Sum and product
 - Sum and product
 - 1.1.2 Transpose matrix

Estructura del curs. Teoria

2.5.2 Stokes' theorem

✓ Stokes' theorem

2.5.3 Conservative fields

2.5.4 Gauss' theorem

✓ Gauss' theorem

✓ Final quiz: Calculus

3 Ordinary Differential Equations

3.0 First order ODE

3.0.1 General Form

3.0.2 Initial value problem

3.0.3 Cauchy-Peano theorem

3.0.4 Some analytically solvable problems

✓ Solving first order ODEs

3.1 Higher-order ODE

3.1.1 General form

3.1.2 Initial and boundary conditions

3.1.3 Linear equations with constant coefficients

✓ Solving higher-order ODEs

3.2 Examples

✓ Final quiz: Ordinary differential equations

4 Partial Differential Equations

4.0 General form and classification

3.1.2 Initial and boundary conditions

Property

The general solution of an ODE is the most general function $y(x)$ that satisfies the equation; it will contain constants of integration. The general solution must satisfy the initial or boundary condition.

Definition (Initial problem).

Find the function y , satisfying

$$\begin{cases} F(x; y(x), y'(x), \dots, y^{(m)}(x)) = 0 & \text{for } a < x < b, \\ y(a) = y_0, \end{cases}$$

Definition (Dirichlet boundary problem).

Find the function y , satisfying

$$\begin{cases} F(x; y(x), y'(x), \dots, y^{(m)}(x)) = 0 & \text{for } a < x < b, \\ y(a) = y_0, \\ y(b) = y_1, \end{cases}$$

Definition (Neumann boundary problem).

Exemples. Problemes resolts

3. Some roots are repeated: if λ_1 is repeated k times, then

$$y_c(x) = (c_1 + c_2x + \dots + c_kx^{k-1})e^{\lambda_1 x}$$

Example 3.2.2.

Property

Finding the particular function for $y_p(x)$
Standard trial function

1. If $f(x) = ae^{\gamma x}$,
2. If $f(x) = a_1 \sin x$
3. If $f(x) = a_0 + a_1x$
4. If $f(x)$ is the

Example 3.2.2.

Example 3.2.2.

Given the equation

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = e^x,$$

let us find its complementary function. Considering the equation homogeneous, substituting $y = Ae^{\lambda x}$ and dividing through by $Ae^{\lambda x}$, we obtain the auxiliary equation

$$\lambda^2 - 2\lambda + 1 = 0.$$

The root $\lambda = 1$ occurs twice, therefore

$$y_c(x) = (c_1 + c_2x)e^x.$$

Example 3.2.3.

Example 3.3.1.

Example 3.3.1.

The elastic beam: we consider a model for a horizontal clamped beam (placed as in figure 3.1) made of an elastic material subject to a v the beam satisfies

$$\begin{cases} \frac{1}{EI}u^{(4)}(x) = f(x) & \text{for } 0 < x < 1, \\ u(0) = u'(0) = u(1) = u'(1) = 0. \end{cases}$$

being E Young's Modulus and I is the section second moment of area.

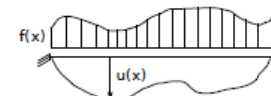


Figure 3.1: Elastic beam scheme

Example 4.4.2.

In the special case of heat propagation in an isotropic and homogeneous medium in a 3-dimensional space, this equation is

$$\kappa \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) = \frac{\partial u}{\partial t}$$

where

- $u = u(t, x, y, z)$ is temperature as a function of time and space
- $\frac{\partial u}{\partial t}$ is the rate of change of temperature at a point over time
- u_{xx} , u_{yy} and u_{zz} are the second spatial derivatives (thermal conductions) of temperature in the x , y , and z directions, respectively
- κ is now the thermal diffusivity, a material-specific quantity depending on the thermal conductivity, the density and the heat capacity

You can visualize it with this animation:

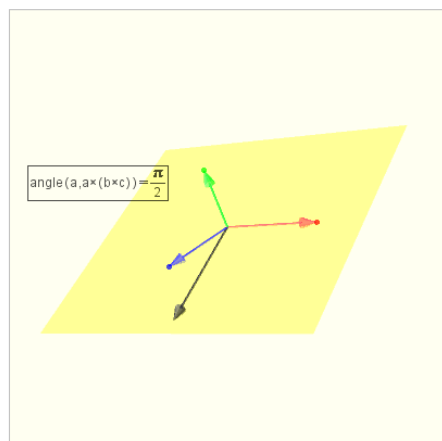
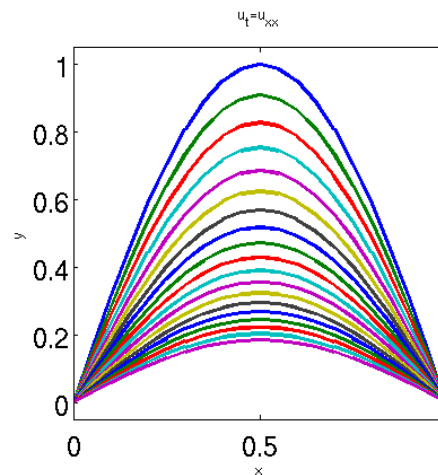


Figure 1.3: Triple vector product



Tests interactius d'autoavaluació

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1

Marks: 0/1

Solve this separate-variable ordinary differential equation.

$$\frac{dy}{dx} = (x^2 - 1) \cdot y(x) + (x^2 - 1)$$

Type only the function definition (if $y(x)=\sin(x)$, type $\sin(x)$)

Answer

Edit

General

Operators

Symbols

Big Ops.

Matrix

Arrows

Greek

Script and accent

Other

$\left(\right)$
 $\left[\right]$
 $\langle \rangle$

$\frac{\Box}{\Box}$
 $\sqrt{\Box}$
 $\sqrt[n]{\Box}$

$\sqrt{\Box}$
 $\frac{\Box}{\Box}$

$\sin(x)$

Submit

Incorrect

Marks for this submission: 0/1. This submission attracted a penalty of 0.1.

Save without submitting

Submit page

Submit all and finish

Page: 1 2 3 4 5 (Next)

Agraïm la col·laboració de Alba Pros Parés i de l'empresa Maths for More així com els ajuts rebuts a diferents convocatòries de la UPC-BarcelonaTech i de l'Escola Tècnica Superior d'Enginyers de Camins, Canals i Ports de Barcelona.

